COMMUNICATION LIMITS AND ISOLATED-NETWORK OPERATION

Aleš Krutina, Václav Kraus

ABSTRACT

The paper describes borders and limitations for the isolated network operation from the communications point of view. It shows the issues especially when using wireless communication. The document is mainly focused on Smart Micro-Grid network and its island operation. It shows the potential of modern grids and also a few potential problems which are caused by the borders of current technology. There is also mentioned how the technology could be used hand in hand with the time limits of the Smart Micro-Grids network.

KEYWORDS

GPRS, Island Operation, Smart Micro-Grid, Wireless

1. INTRODUCTION

In the last few years a new technology called Smart Grid or Smart Micro Grid become in behalf of energy industry. The new concept brings new capabilities of the operating and the regulation as well as an energy conservation or higher reliability of the supply. Nevertheless, the boom called "Smart Grid" brings some side effects which needn't to be very positive. The biggest problem with the Smart Grid is excessive expectations which are out of the technical reality. These expectations are remarkable especially on the field of distributive control of the isolated network.

2. ISLAND OPERATION

The island operation is a special case of controlling of the particular isolated energy part without any straight feedback to the central dispatching or the distribution network. This isolated network is not in correlation with the grid and its frequency. The islanded mode is the possible state mainly during a blackout or local disconnection of the grid. Nevertheless, island operation must provide much more functionality and "smartness" such as self-healing ability, self-control ability or higher level of interactivity. The system must be able to process and calculate current and future state of the micro grid and adapt the load management. To success, the micro grid needs to have a very good bus system and the communication infrastructure at all. This could be a problem when using wireless communications which are very popular among many manufactures.

The bottleneck of the micro grid controlling is the transition between normal and island operation. The phase shift is the main factor for the transition from the island to the normal operation state. Another transition has a problem with an energy supply loss which could be very important especially for emergency power supply.

The most critical moment for the transition comes when the micro grid is not deterministically disconnected from the grid. This kind of event is usually caused by the failure of one or more power busses. The time needed to process the event is in range of milliseconds. This drives the need of the

high quality communication infrastructure as well as the smart control system which must enable the transition without any power supply losses.

The transition process includes these steps:

1/ Power bus failure
2/ Event into micro grid control system
3/ Grid protection devices starts its voltage integration and try to evaluate the state of the grid (failure or not)
4/ Event is being processed in the control system
5/ Control system sends the command to the activator
6/ Reaction of the activator (circuit breakers, switchers)

We can see that the procedure above is time consuming and when having one or two hundreds milliseconds for the whole process it could be called time critical task. This time issue needs to be taken account when designing a micro grid. It is more than obvious that the main factor is the time or strictly speaking the communication infrastructure.

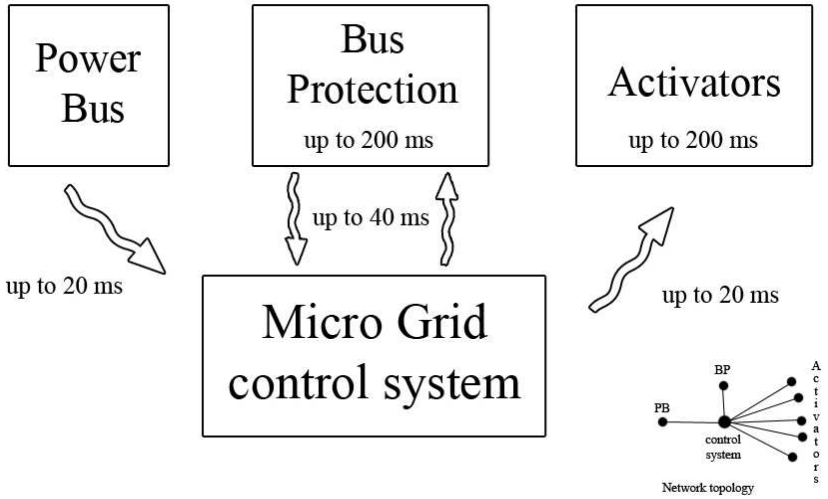

Figure 1 – Delays in the ZigBee network

3. COMMUNICATION

The wireless communication is a big phenomenon of nowadays. This technology is very often called as suitable for Smart Grid and micro grids networks. Nevertheless, their limits are very often hidden in delays and latencies, which are very important parameters for those kinds of new energy networks.

On the figure 1 are depicted common latencies of ZigBee network [2]. Typical value of the ZigBee network is 20 ms per single hop which means 40ms for every single command with the acknowledgment. However, the value 20 ms per a hop is not deterministic and strongly depends on the data traffic in the network. In case of the micro grid the traffic is not so high but there is a lot of nodes which makes the traffic high as well. Moreover, there is a limitation in the distance which is 300m (in Europe, 2.4GHz) per one hop. For two nodes which are two hops far from each other it means the latency is twice longer and the latency is getting longer with the distance.

The ZigBee is called suitable for the Smart Grid but it strongly depends on the application. It is not definitely suitable for the controlling of the large micro grid network due to high latency and distance limits. As the ZigBee is not suitable for this kind of application still it is more than useful for the Smart Meter application. Nevertheless, the success on this field doesn’t mean the success on the field of controlling and it should be always on man’s mind.

If we take into account the wireless technology and its possibilities on the field of the energy industry there are not many ways. The limitations could be demonstrated on the latency parameter of different technologies. As the break point of the latency we chose the value of 250ms which is the value for larger industrial factory. The value of 250 ms represents the ability of the factory to stay

fully supplied and it is also the time for the reaction of the micro grid control system. If we know this background we can have a look on the different wireless technology as it is shown in table 1 [1].

Table 1 – Latencies of the wireless communication channels

Technology	Latency (typical)	Distance range
GPRS	0,6 s	Kilometers
UMTS HSDPA	< 50 ms	Kilometers
ZigBee	20 ms (point to point)	300 m outdoor (Europe) 1 mile (North America)

s = second, m = meter

The table 1 shows that many common technologies are not suitable for the application in micro grid. For instance the latency of GPRS is more than two times higher than the value of 250ms. Also the ZigBee technology has very specific borders. The main limitation for ZigBee is the distance range. In comparison with the value 250ms is ZigBee theoretically applicable up to 3600 meters. Only technology which seems to be very promising is the new version of UMTS called HSDPA (Universal mobile telecommunications system – high speed downlink packet access) which offers higher bit rate hand in hand with the low latency time.

4. CONCLUSION

If we compare the common technologies in table 1 it is clear that UMTS and the ZigBee could be used as a wireless communication channel in micro grid networks. The only parameter which was taken into account was the latency. However, the latency is not only parameter of the whole system. Other important parameters are robustness, reliability or EMC resistance and all of those parameters should be taken into account.

In this document we wanted to demonstrate that there is no and only technology which could be called as smart grid compliant. Good and reliable system should be a fusion of the best technologies of nowadays. Moreover, it strongly depends on the implementation of the particular components into the system.

REFERENCES

[1] (Journal Online Sources style) J.Kuruc, Srovnání: nejrychleší mobilní internet. (2010, march). *Journal* [internet]. Available: http://www.mobilmania.cz/

[2] (Handbook style) Farahani,S.: ZIGBEE WIRELESS NETWORKS and TRANCIEVERS, Elsevier 2008, ISBN: 978-0-7506-8393-7

ACKNOWLEDGMENT

This work was supported and granted by project no. SGS 2010-018.

Authors:

Ing. Aleš Krutina
University of West Bohemia
Department of Electrical Power Engineering and Environmental Engineering
Univerzitní 8, 306 14 Plzeň, Czech Republic
E-mail: krutina@kee.zcu.cz

Ing. Václav Kraus
University of West Bohemia
Department of Applied Electronics
Univerzitní 8, 306 14 Plzeň, Czech Republic
E-mail: krausv@kae.zcu.cz